MODIS SCIENCE TEAM MEMBER
Quarterly Report (January - March 1996)

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a) Task Objectives

The objectives of this phase of the project were: to continue the research program developing the 'at-launch' algorithms for MODIS atmospheric correction, vegetation indices, fire detection and land cover and to build the infrastructure and collaboration to permit the research to be undertaken. The completion of the ATBD revisions and the development of the beta code were given a high priority. The project has developed a number of collaborative projects which are intended to expand the scope of the team members activities and involve a larger community in the MODIS research. Due to the small number of researchers addressing the issues necessary for the methodological advances needed for MODIS, emphasis has been given to developing collaborative research and MODIS outreach through the IGBP Data and Information System Core Project. In addition, the goals of the MODIS project, the status of the instrument and preliminary results of the research were presented at key scientific meetings. The project was also represented at the MODIS Team meeting. Results of the studies undertaken as part of the project are in the process of being written up and submitted for publication.

b) Tasks Accomplished (Data analysis and interpretation)

1st Quarter (Jan - March 1996)

Specifically the project has addressed the following tasks over this three month period:

MODIS Atmospheric Correction:

A meeting was held with I. Fung of the Sellers / Mooney IDS activity in January at GISS to examine the feasibility of using an aerosol by-product from the AVHRR atmospheric correction /MODIS prototyping activity as an input to the IDS transport models and GCM modeling activities.

Emphasis has been given to the generation of the V1 code and the associated test data sets. This has consisted of 1) rewriting portions of the code that needed corrections and/or reorganization to improve clarity and simplify processing, 2) identifying and optimizing computationally intensive areas, and 3) incorporating new and/or replacement modules and functions into the Beta 3 code.

The following new/replacement routines were incorporated into the Beta 3 code:

New BRDF (bidirectional reflectance distribution function)-atmosphere coupling correction module, written by Privette.

Code to utilize DAO water vapor and surface pressure ancillary data sets, written by Nazmi El Saleous.

Revised HDF library to read and write V1 HDF files, written by Robert Wolfe.

Code to read new bad detector information, written by Robert Wolfe.

Code to utilize land cover ancillary data base, written by Robert Wolfe.

Changes and additions to the Beta 3 code included:

Modified program to use the V1 cloud mask, which is stored in an entirely different format than the Beta 3 cloud mask product.

Changed code to be in compliance with the requirements specified in the MODIS Software Development Standards and Guidelines document.

Added several new utility functions to eliminate redundant code sequences and make our interface to the SDP Toolkit cleaner and less awkward.

The new ancillary data bases (of which there were many) has been documented and the V1 delivery package produced.

Resolved incompatibilities between our HDF ingest code to work the V1 synthetic data sets, the format of which was undergoing regular changes during some of this period.

MODIS Atmosphere/BRDF Coupling

We continue to test the best method for incorporating BRDF coupling parameters in the atmospheric correction. Our beta delivery presumed we would use coefficients of the previous 16-day BU BRDF linear models. The linearity allowed us to precompute parameters of the coupling terms, then multiply these parameters by the BU coefficients.

Recently, we have investigated linking the atmospheric correction with the MT-style look up tables. For each of the 11 LAI levels in each of the 6 biomes, we precomputed the bidirectional reflectance and coupling terms for each of the 4 visible-NIR bands. In our version 1 delivery, we will look up the biome type for a given pixel from Nemani's global biome map. After atmospheric correction with Lambertian surface assumption, we will compare the BRDF estimates with the precomputed values to determine which LAI level produces the best fit over the first 4 MODIS bands. With this result and the aerosol optical depth, we can immediately access accurate coupling terms from the appropriate LUTs. We have completed a table of grassland BRDF and coupling terms for each LAI value of the MT LUT. Deciduous forest LUTs are currently being produced.

To minimize the size of the LUTs, we are investigating the discretization necessary in LAI, view and solar geometry. We are also considering the effects of errors in determination of biome, LAI, and optical depth. So far, we've only used FIFE AVHRR data for in this step, however BOREAS and other data sets will also be employed.

Finally, we continue to evaluate the ability of simple BRDF models to estimate nadir reflectance and albedo. We are including our table generated reflectance values in this comparison to assess its relative accuracy. Our recent work with Betty Walter-Shea (Univ. Nebraska; in preparation) shows which view angles have veg. indices most correlated with LAI and fAPAR. Combining results from these two studies should guide the Montana and Arizona MODLAND groups in optimally estimating LAI/fAPAR from limited satellite sampling sets. PARABOLA data is being used heavily in our comparisons, and results will be presented at the upcoming BOREAS meeting in Toronto, and will be submitted for publication in the first BOREAS special issue.

MODIS Land Cover (w. Strahler et al.):

No direct activity this period due to emphasis on V1 Delivery of other products. Indirect activities continue through collaboration with Dr R Defries and Dr J Townshend at UMD on AVHRR prototyping for MODIS land cover studies.

MODIS Fire Detection (w. Kaufman)

Dr L. Flynn, Justice and Kaufman met in January at GSFC to discuss the V1 plans for the Fire Code Delivery due in June 1996. The research agenda for Flynn were developed for 1996. Emphasis will be given to refining the emitted energy product and further developing the smoldering ratio product. A simulation activity is being conducted by Giglio to test the off nadir effects on fire detection. Comparisons are on going with the AVHRR, GOES and DMSP as part of a fire detection validation activity.

Flynn's activities have centered around two specific objectives leading to the submission for publication of two pieces of work supporting the efforts of the MODIS Fire Team. As indicated in the contract proposal, the University of Hawaii Yellowstone TM data served as a MODIS test 1 km data set for the analysis of spatial degradation of fire details between 30m and 1 km spatial resolution, and the differences in emitted energy from identical fires subsampled at 30 m and 1 km resolutions. The results showed that emitted energy varied by at most only 20%, which means that the MODIS estimates of fire energy (based on 1 km data) will be very accurate. The second publication arose out of data collected during a trip to San Diego to get supplementary spectral data on dry climate vegetation. A flight over the San Diego area provided a unique data set which helped to demonstrate the robustness of an empirical relationship between the reflectance of vegetation at 0.49, 0.66 and 2.2 microns. This relationship will help to separate the reflectance contribution of fire aerosols from that of the natural background. A paper has been prepared for submission which will go out in late April to early May.

An extension of the current contract to May 31, 1996 allowed progress to continue beyond the originally planned February 29th, 1996 termination date. A host of new specific directives for the coming year were identified during a meeting at the Goddard Space Flight Center in early March. Information on fire temperatures was provide to Dr. Kai Yang for incorporation into the official MODIS Test Data sets. In addition, work was begun on the analysis of the empirical energy calculation provided in the MODIS ATBD. Direction was given on the use of MODIS 3.95 micron channels (21 and 22). Finally, it was recognized that the saturation problems of 30 - 40m spatial resolution sensors have limited the effectiveness of MODIS test data sets. To overcome this and provide a suitable test for the Version 1 MODIS Fire Algorithm, the Landsat TM data set will be used to provide a template for a new fire data set. Theoretical values for fires are being substituted for saturated values in fire pixels. This should lead to more realistic values for fire responses when resampled to 1 km MODIS resolution.

MODIS Vegetation Index:(w. Huete)

Dr A Huete visited GSFC in mid - February to discuss the V1 plan for the Modis Vegetation Indices. The plan was developed including the Level 3 compositing requirements. An approach was agreed upon which would use restricted view angle maximum value compositing as a fallback to a Walthall Model curve fitting approach when insufficient data are available.

c) Data / Analysis / Interpretation

Considerable effort was put in by the PI in developing the concept, designing the agenda and chairing the EOS Test Site meeting. A major achievement was to raise the level of coordination on in-situ measurements for EOS building on the foundation of on-going programs .

The MODIS requirements are now included in the plan for an EOS Test Site initiative. Dr Vermote co-chaired the breakout group on atmospheric requirements, Dr. Privette helped develop the vegetation characterization requirements. A summary report is in the process of being written up.

d) Meetings

Aerosol meeting in New York: January 4-5th

SAGE III algorithm review: January 17-18th

MCST Science Advisory Panel: January 23th

MODIS Fire Algorithm Meeting: March 5-6

MVI Meeting: March 12-13th

EOS Test Site Meeting: March 14-15th

POLDER Science Team Meeting: March 20-25th

* Upcoming Meetings

MODIS Team Meeting:May 1-3
SWAMP Land Review: May 15-16th
EDC DAAC SAP: May 9-10th

e) Obstacles

f) Publications

Submitted papers
Kaufman, Y. J., Tanre, D., Remer, L., Vermote, E. and Holben, B. (1995), Operational Remote Sensing of Tropospheric Aerosol Over the Land from EOS-MODIS, Journ. Geophys. Res.

Vermote, E. F., El Saleous, N. Z., Justice, C. O., Kaufman, Y. J., Privette, J. L., Remer, L., Roger, J. C. and Tanre, D. (1996), Atmospheric correction of visible to middle infrared EOS-MODIS data over land surface, background, operational algorithm and validation, Journ. of Geophys. Res. in preparation:

In preparation papers:
R. Wolfe and E. Vermote - Level 2G Processing

Walter-Shea, E. A., J. L. Privette, D. Cornell, M. A. Mesarch, and C. J. Hays (1996), Sensitivity of relations between spectral vegetation indices and absorbed radiation and leaf area index in alfalfa, Remote Sens. Environ.